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Full Length Research Article

Phytosociological and Ethnobotanical Aspects of Selected Sacred Groves in Different Agroclimatic Zones of Pune District, India

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Abstract

Nature conservation is an ancient tradition in India. Sacred groves have existed for thousands of years and have been performing the ecological role by supporting the local biodiversity. Sacred groves are threatened due to lack of conservation priority and thus need attention for conservation. Phytosociological analyses coupled with ethnobotanical studies can contribute to baseline data for conservation planning. Present study attempts to understand phytosociological and ethnobotanical aspects of sacred groves situated in different agroclimatic zones of Pune District. Field visits to five sacred grove sites and semi-structured interviews with local experienced knowledgeable individuals were conducted for data collection. Each sacred grove is a unique ecosystem and displays its unique characteristic biodiversity profile. All the studied sacred grove sites showed presence of different endemic and IUCN RET plant species. Sacred groves are rich in wild edible and medicinally important plant species and the local communities have folklore associated with them. Sacred groves need to be protected for their important role in cultural and environmental wellbeing.

***Key words*:** Sacred grove, Pune district, Agroclimatic zones, Phytosociology, Ethnobotany

Sacred natural sites, are 'areas of land or water having special spiritual, significance to people and communities' [1]. Nature conservation is an ancient tradition in India. One such significant tradition is of dedicating patches of forests to some deities as sacred groves [2] (*Devrai* or *Dev-Rahat* in vernacular). Many sacred groves have great importance to biodiversity conservation and their spiritual values [1]. Sacred groves have existed for thousands of years and have been performing the ecological role by supporting the local biodiversity. Common local flora, especially trees, that have once disappeared from surrounding lands can now only be seen in sacred groves [3]. Such sites are also repositories of a number of wild edible and ethno-medicinal resources. Phytosociological data helps in understanding vegetational environment in the area whereas ethnobotanical studies help in understanding traditional knowledge of local communities associated with plants in the area. Phytosociological analyses coupled with ethnobotanical studies can contribute to baseline data for conservation planning. Pune district is situated in western Maharashtra with its western boundary defined by the Western Ghats (Sahyadri mountain ranges). It extends eastwards to the Deccan peninsular region through eastern slopes and offshoots of Sahyadri.

According to National Agricultural Research Project (NARP) of Indian Council of Agricultural Research (ICAR), Pune District falls under agroclimatic zones: Ghat Zone (altitude 1000m on coastal side, 600m away from the coast, rainfall 5000mm), Transition Zone I (rainfall 1750 – 2000mm, paddy growing area in western hilly parts of Pune) and Transition Zone II (almost parallel to regions of Transition Zone I, summers and winters are warmer, trap soils) and scarcity zone (draught prone area, rainfall about 700mm ± 50mm, calcareous soils, uncertainty of rains) [4]. Present study attempts to understand phytosociological and ethnobotanical aspects of selected sacred groves situated in different agroclimatic zones of Pune district. These are Shirgaon, Bhordi, Panwadi, Ajeevali and Durgawadi (Fig 1). In case of Shirgaon there are two adjacent sacred groves and in case Bhordi there are three adjacent sacred groves included as part of the study site. (Table 1) describes the study sites with reference to their Taluka wise location, latitude – longitude, agroclimatic zone, altitude, area and presiding deity.

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Table 1 Details of study sites

Study site	Taluka	Latitude - Longitude	Agroclimatic zone	Altitude (mASL)	Area (Acres)	Deity
Shirgaon	Bhor	18.092N, 73.628E	Transition Zone I	677	24	Janani (Durga), Dhoop
Bhordi	Velhe	18.225N, 73.564E	Ghat Zone	683	37	Mahadev, Somjai, Bahiravnath
Panwadi	Saswad	18.262N, 74.030E	Scarcity Zone	817	7.75	Lal chundi / Lachundai Devi
Ajeevali	Maval	18.594N, 73.488E	Transition Zone I	820	40	Waghjai
Durgawadi	Junnar	18.092N, 73.628E	Ghat Zone	1158	45	Durgubai / Durgadevi

MATERIALS AND METHODS

Selection of study sites was done so as to cover different agroclimatic zones [4] in Pune District. GPS locations of the study sites were recorded using GPS, Garmin e-trex30.

1. *Phytosociology*: Field visits were conducted during the years 2020-2022 for studying vegetation in the study sites. Each site was visited twice so as to cover perennial and seasonal vegetation to include habits: trees, shrubs, climbers and herbs except Poaceae. Data was also analyzed for endemism, IUCN Red List status and presence of selected invasive species at each location.

2. *Ethnobotany*: semi-structured interviews with the local community representatives including *Gurav* (local priest of the deities in the sacred grove) were conducted for understanding traditional knowledge associated with plant species and their usage for food and medicinal purposes.

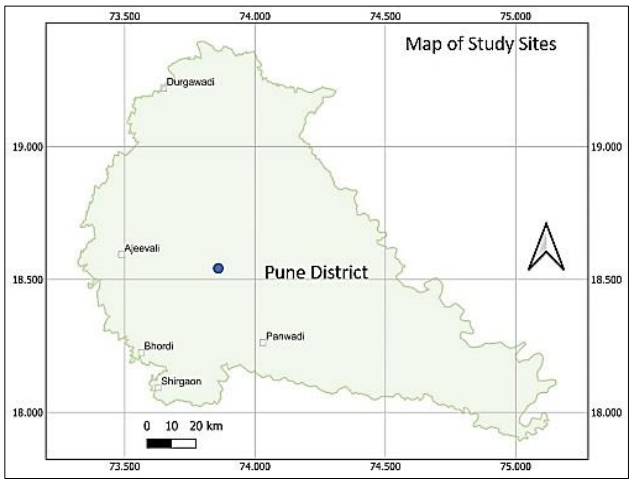

Fig 1 Map of Pune district showing locations of study sites

RESULTS AND DISCUSSION

Vegetation surveys at selected study sites and their phytosociological analysis revealed that: Shirgaon sacred groves harbour a total of 50 families represented by 89 genera and 104 species. (Fig 2) shows dominant top 15 families at Shirgaon. They are represented by 63 species which are 60.5% of total species observed at this site. At Shirgaon, 29 (58%) families are represented by only one species. Bhordi sacred groves harbour a total of 54 families represented by 101 genera and 125 species. (Fig 3) shows dominant top 15 families at Bhordi. They are represented by 72 species which are 57.6% of total species observed at this site. At Bhordi, 25 (46.2%) families are represented by only one species. Panwadi sacred grove harbours a total of 32 families represented by 54 genera and 58 species. (Fig 4) shows dominant top 15 families at Panwadi. They are represented by 41 species which are 70.6% of total species observed at this site. At Panwadi, 21 (65.6%) families are represented by only one species. Ajeevali sacred grove harbours a total of 41 families represented by 65 genera and 77 species. (Fig 5) shows dominant top 15 families at Ajeevali. They are represented by 50 species which are 64.9% of total species observed at this site. At Ajeevali, 25 (60.9%) families are represented by only one species. Durgawadi sacred grove harbours a total of 43 families represented by 92 genera and 96 species. (Fig 6) shows dominant top 15 families at Durgawadi. They are represented by 67 species which are 69.7% of total species observed at this site. At Durgawadi, 25 (58.1%) families are represented by only one species.

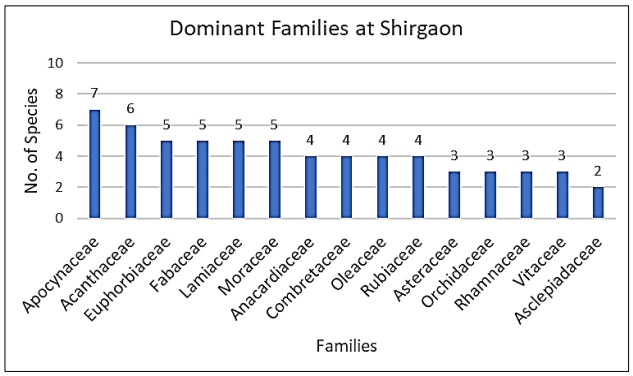

Fig 2 Dominant plant families at Shirgaon

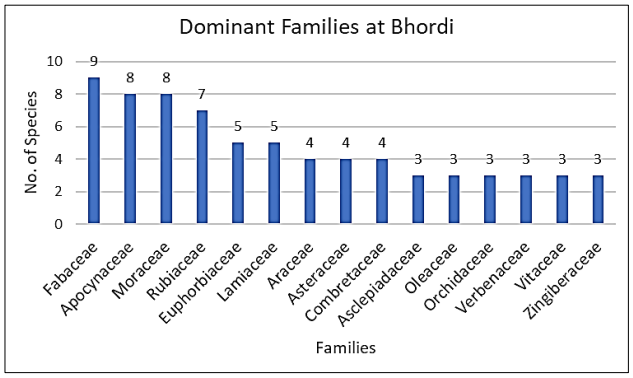

Fig 3 Dominant plant families at Bhordi

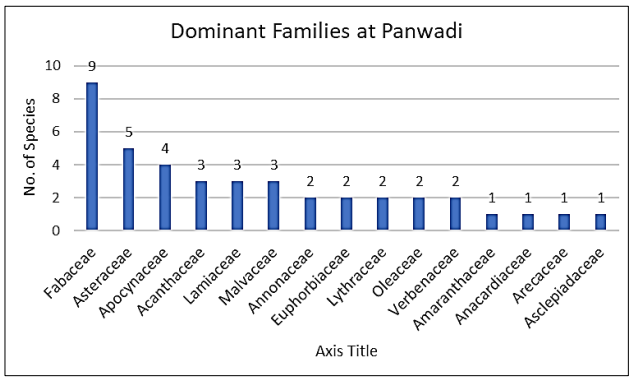

Fig 4 Dominant plant families at Panwadi

Observed species were further classified habit wise for each of the study sites (Fig 7). Sacred groves at Shirgaon show presence of 40 (38.4%) tree species, 27 (25.9%) shrub species, 21 (20.1%) herb species and 16 (15.3%) climber species. Sacred

groves at Bhordi show presence of 44 (35.2%) tree species, 23 (20%) shrub species, 34 (27.2%) herb species and 24 (19.2%) climber species. Dense tree cover does not encourage growth of herbaceous species inside sacred groves. Bhordi sacred grove shows higher number of herbaceous species, which could be due to disturbance and loss of canopy cover. Sacred grove at Panwadi shows presence of 23 (39.6%) tree species, 16 (27.5%) shrub species, 13 (22.4%) herb species and 6 (10.3%) climber species. Sacred grove at Ajeevali shows presence of 30 (38.9%) tree species, 17 (22.1%) shrub species, 20 (25.9%) herb species and 10 (12.9%) climber species. Sacred grove at Durgawadi shows presence of 39 (40.6%) tree species, 21 (21.8%) shrub species, 30 (31.2%) herb species and 6 (6.2%) climber species. Since Durgawadi sacred grove displays more diversity of microhabitats [5], it shows higher number of herbaceous species.

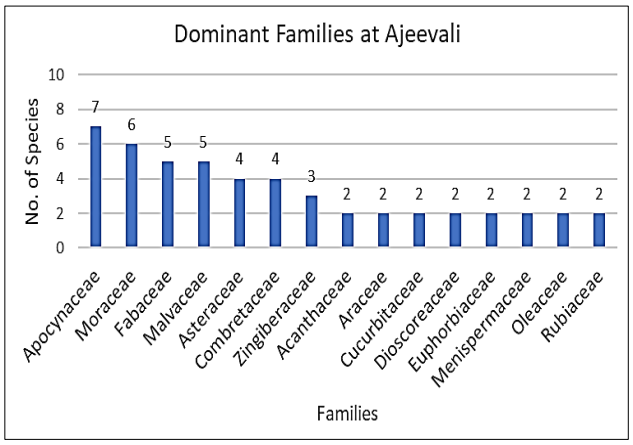

Fig 5 Dominant plant families at Ajeevali

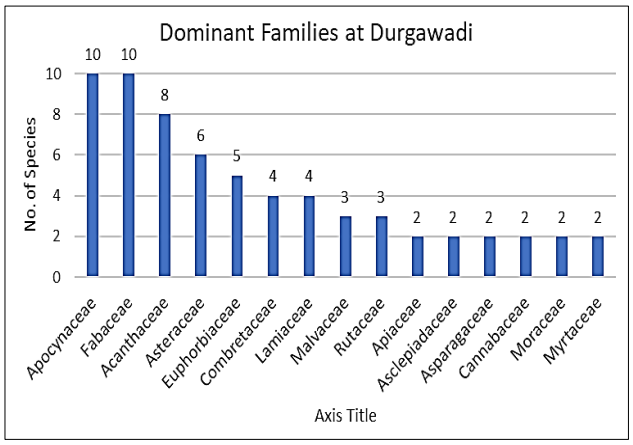

Fig 6 Dominant plant families at Durgawadi

Table 2 Phytosociological analysis based on forest storeys and habitat types

	Study Sites	Shirgaon	Bhordi	Panwadi	Ajeevali	Durgawadi
Habit	Dominant habitats	Evergreen, Semi-evergreen	Semi-evergreen, Moist Deciduous	Dry Deciduous, Moist deciduous	Semi-evergreen	Moist Deciduous, Semi-evergreen Plateau
Trees	Dominant families	Moraceae, Anacardiaceae, Combretaceae,	Moraceae, Fabaceae, Combretaceae, Rubiaceae	Fabaceae, Annonaceae, Malvaceae	Moraceae, Combretaceae, Malvaceae	Fabaceae, Combretaceae, Rutaceae
	No. of families	25	20	16	18	21
	No. of genera	34	32	20	23	35
	No. of species	40	44	23	30	39
Shrubs	Dominant families	Apocynaceae, Lamiaceae, Vitaceae	Lamiaceae, Rubiaceae, Verbenaceae	Apocynaceae, Euphorbiaceae	Apocynaceae	Apocynaceae, Euphorbiaceae, Lamiaceae, Verbenaceae
	No. of Families	17	13	13	15	15
	No. of Genera	25	22	15	17	20
	No. of Species	27	23	16	17	21
Climbers	Dominant Families	Fabaceae, Smilacaceae	Apocynaceae, Fabaceae, Asclepiadaceae, Cucurbitaceae, Dioscoreaceae	Six families are represented by only one species each	Fabaceae	Six families are represented by only one species each
	No. of Families	12	17	6	7	6
	No. of Genera	15	22	6	9	6
	No. of Species	16	24	6	10	6
Herbs	Dominant Families	Acanthaceae, Orchidaceae, Apocynaceae, Asteraceae, Euphorbiaceae, Zingiberaceae	Araceae, Asteraceae, Apocynaceae, Euphorbiaceae, Orchidaceae, Zingiberaceae	Asteraceae, Acanthaceae, Lamiaceae	Apocynaceae, Asteraceae, Zingiberaceae, Araceae	Acanthaceae, Asteraceae, Apocynaceae, Orchidaceae
	No. of Families	12	16	8	11	14
	No. of Genera	20	29	13	17	29
	No. of Species	21	34	13	20	30

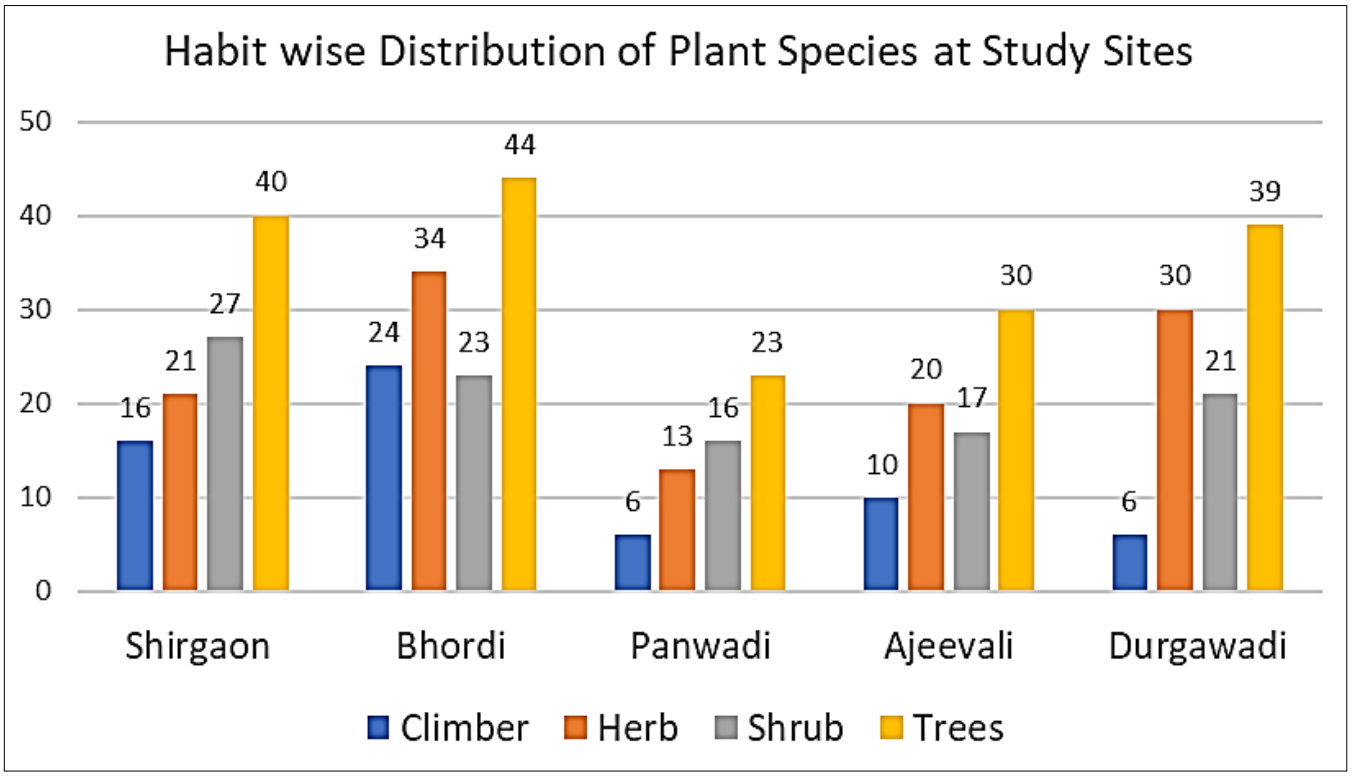

Fig 7 Habit wise Distribution of Plant Species at Study Sites

The vegetation data were further analyzed based on the dominant families observed in different layers of the forests and dominant habitat types observed at the study sites (Table 2). Most of the sacred groves in this region exhibit a small number of montane subtropical evergreen, moist deciduous and some dry deciduous elements [6]. With reference to Champion and Seth classification [7] sacred groves at Shirgaon have evergreen and semi-evergreen as dominant habitats, sacred groves at Bhordi have moist deciduous and semi-evergreen vegetation represented by *Memeceylon – Syzigium – Actinodaphne* community and *Bridelia – Syzigium – Terminalia – Ficus* community. Dry and moist deciduous forest community was observed at Panwadi sacred grove represented by Terminalia – *Syzigium – Tectona* community. Ajeevali and Durgawadi sacred groves have semi-evergreen and moist deciduous dominant habitats and vegetation communities. However, the surrounding landscape of all these sites is characterized by a combination of agriculture, grazing lands, fallow lands and stunted forests. Once part of a continuous forest patch, these sacred groves are turning into island ecosystems due to exploitation of natural resources and deforestation for livelihood purposes and urban development [8].

Table 3 Plant species richness at study sites

Study site	Area (Acres)	No. of species	Species richness
Shirgaon	24.00	104	4.33
Bhordi	37.00	125	3.38
Panwadi	7.75	58	7.48
Ajeevali	40.00	77	1.93
Durgawadi	45.00	96	2.13

Species richness, defined as the number of species per unit area, is perhaps the simplest measure of biodiversity; understanding the factors that affect and are affected by small scale species richness is fundamental to community ecology [9]. While sacred groves of Ajeevali and Durgawadi show lower values for species richness; 1.93 and 2.13 respectively, sacred grove of Panwadi shows highest value of 7.48 for species richness. Sacred groves of Shirgaon and Bhordi show species richness values of 4.33 and 3.38 respectively (Table 3). The causes for the variation seen in species richness values among these sites could be due to their geographical locations, agroclimatic zones they represent and disturbance in the form of habitat fragmentation, reduction in canopy and impact of grazing. Disturbed ecosystems also make it easy for the invasive species to enter, thrive and become dominant. Understanding of the factors that influence species richness is particularly important for applying the concept to biodiversity conservation [9].

Occurrence of three invasive species *Chromolaena odorata, Cosmos sulphureus* and *Lantana camara* was recorded at the study sites. *Choromolaena odorata* was present at all the study sites except Bhordi. *Cosmos sulphureus* was present only at Panwadi, Bhordi and Durgawadi. *Lantana camara* was present at all the study sites except Shirgaon. Presence of these invasive plant species indicate disturbances due to roads and construction work.

Vegetation data were further analysed for presence of rare, endangered and threatened species based on the IUCN Red List of Threatened Species [10] and for presence of endemic species [11-13] at each site (Table 4). All the sacred grove sites showed presence of different RET plant species viz - Vulnerable species: *Curcuma pseudomontana, Santalum album, Canthium dicoccum* and *Garcinia indica;* Near Threatened species: *Litsea stocksii, Ensete superbum, Habenaria grandifloriformis, Dalbergia horrida, Tabernaemontana heyneana* and *Phaseolus khandalensis;* Critically Rare species: *Nothopegia castaneifolia* and Endangered species: *Tectona grandis* and *Abutilon ranadei* were observed at the study sites. Endemic species observed include *Strobilanthes callosus, Holigarna grahamii, Heracleum pinda, Glochidion hohenackeri, Lagerstroemia microcarpa, Habenaria grandifloriformis, Atalantia racemosa* and *Zingiber neesanum*. Dhoop-rahat sacred grove at Shirgaon is the northernmost known location of *Canarium strictum* in northern Western Ghats [14]. Locally rare species *Ficus tsjahela* [15] was observed in sacred grove of Bhordi. Sacred

groves are the last refuge for many plant species like lianas, epiphytes and other shade loving plants with special habitat preferences [16]. In the present study lianas like *Gnetum ula, Entada rheedei,* and *Dalbergia horrida* and epiphytic orchids like *Dendrobium barbatulum* and *Eria dalzellii* were observed. Presence of RET and endemic plant species in theses localities indicate that these sites need priority in conservation agenda [10], [17].

Table 4 Number of endemic and IUCN red listed plant species at study sites

Study sites	Shirgaon	Bhordi	Panwadi	Ajeevali	Durgawadi
Number of RET species	3	5	2	5	5
Number of endemic species	12	20	6	11	14

The selected study sites show diverse vegetation elements. Fifty-nine plant species were found at three or more study sites. Shirgaon, Bhordi, Panwadi, Ajeevali and Durgawadi show 22, 37, 12, 9, 30 number of unique species respectively not seen in rest of the study sites, which could be because of their diverse climatic zones and island effect. This makes each sacred grove a unique ecosystem.

People and communities associated with these sacred grove sites are dependent on agriculture for their livelihood. Rice and millets like *Nachani* (ragi) and *Varai* (barnyard millet) are main crops in the surroundings of Shirgaon, Bhordi and Ajeevali. Panwadi and Durgawadi sites are surrounded by Rice, Jowar and Sugarcane fields. Pastoralism is practiced for milk and meat requirements. The sacred groves shelter several medicinal plants of great value not only for the primary health care of the village communities, but many are also important in modern pharmacopoeia [18]. (Table 5) shows number of wild edible and medicinal plant species found at the study sites. They include medicinal plant species such as *Adhatoda vasica, Hemidesmus indicus, Curcuma pseudomontana, Nothapodytes nimmoniana, Tinospora cordifolia, Tinospora sinensis, Terminalia spp., Garcinia indica, Canarium strictum, Calotropis gigantea and Pongamia pinnata*. Apart from commonly relished fruits from wild plants, other wild edible plant species such as *Semecarpus anacardium, Caryota urens, Momordica dioica, Dioscorea spp., Abrus precatorius, Bombax ceiba, Ficus spp., Clerodendrum serratum, Madhuca longifolia and Cordia myxa* were observed. A special feature of Ajeevali sacred grove is the abundance of fish-tail palms (*Caryota urens*) from which *maadi* - a popular local liquor (known to have medicinal properties), is extracted commercially [19-20]. At *Dhoop-rahat* sacred grove of Shirgaon, the resin *Dhoop* is extracted traditionally for medicinal and ritualistic purposes [21]. There are certain traditional harvesting practices associated with these species. In sacred groves, cutting of tree branches is generally prohibited however, permission can be obtained if they are to be used for medicinal purpose [22]. With changing times, traditional knowledge associated with these species is not getting effectively transferred from previous generations to the newer generations. Although local people are aware about presence and use of locally found medicinal and edible plants, their usage now-a-days is decreasing.

Table 5 Number of medicinal and wild edible plant species at study sites

Study sites	Shirgaon	Bhordi	Panwadi	Ajeevali	Durgawadi
Number of medicinal plants	25	28	25	28	33
Number of wild edible plants	24	32	22	27	24

CONCLUSION

Sacred groves harbour climax vegetation and are home to important endemic and globally and locally rare and vulnerable species of plants and dependent animals. Sacred groves in different agroclimatic zones show different vegetation patterns. Along with climatic conditions, other factors such as changes in surrounding landscape influence the vegetation communities of the sacred groves. Each sacred grove, thus, is a unique ecosystem and displays its unique characteristic biodiversity profile. Sacred groves are rich in wild edible and medicinally important plant species and the local communities have knowledge associated with the same. Further studies on sustainable use of wild edible and medicinal resources can ensure continuity of these traditional practices. Sacred groves are threatened due to lack of conservation priority and thus need attention for conservation of their rich and unique biodiversity and associated ethnobotanical knowledge.

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